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LISTS OF SPECIES

Ichthyofauna of coastal lakes and the Igaraçu River in Ilha Grande, Delta do Parnaíba, Parnaíba, Piauí State, northeastern Brazil

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ABSTRACT: This study aims to provide a list of fish species from the Igaraçu River and some lakes of the lower Parnaíba River, Delta do Parnaíba, northeastern state of Piauí, Brazil. Eleven collecting points were sampled in a coastal area, in a wind farm, during the dry season in November 2011. A total of 1,023 individuals of 24 species, 13 families and 6 orders were collected. The most representative families in number of species were Characidae, Cichlidae and Curimatidae, respectively. *Astyanax* aff. *bimaculatus*, *Serrapinnus piaba* and *Psellogrammus kennedyi* presented the greatest abundance and distribution among the sampling points. *Oreochromis niloticus* was the only alien species captured. No fishes were captured in five sampling sites. Voucher material is deposited in a new zoological collection, "Coleção Zoológica do Delta do Parnaíba".

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INTRODUCTION

The Parnaíba River basin covers an extent of about 1,700 km of the Caatinga biome, belonging to the Parnaiba freshwater ecoregion, *sensu* Abell *et al.* (2008), located in the mid northern Brazil. Its mouth belongs to the Environmental Protection Area Delta do Parnaíba, an important conservation area which extends to northern states of Maranhão and Ceará. It was created under Decree/96 on 28 August 28 1996. The Delta do Parnaíba is composed of many islands, mangroves, temporary lakes, rivers and sand dunes, and also possesses a coastal plain and an estuary, which fluctuates seasonally. Such hydrological variability throughout the year causes changes in food and movement of the fish that inhabit the lower parts of the Parnaíba River and its adjoining areas (Lima 2012). From a scientific perspective, the Delta do Parnaíba is poorly known.

The knowledge about the number of fish species occurring in the Parnaíba River was based on literature compilation, which included original descriptions, check lists and catalogues of Brazilian fish species until recently (Eigenmann 1910; Fowler 1954; Reis *et al.* 2003; Rosa *et al* 2003; Buckup *et al.* 2007; Costa *et al.* 2010). This information source enabled Albert *et al.* (2011) to characterize the fish fauna o Parnaiba River as potentially diverse with an estimative of about 95 species. Ramos *et al* (2014) recorded 146 freshwater fish species for the basin. The literature on the ichthyofauna of the lower Parnaíba River basin is scarce and deals about identification of commercial fishes (Melo 2012; Nóbrega *et al.* 2010). Additionally, there is little information about fishes which inhabit the lakes near marine environments.

This study provides the first list of fish species from lakes of the northern Piauí, collected in the year 2011 inside and near to a wind power station in the town of Parnaíba, which is very close to the Igaraçu River and the Atlantic Ocean. A dichotomous identification key is also provided.

MATERIAL AND METHODS

Study site

The fieldwork was carried out in November 2011, during the dry season, on Igaraçu River and eleven lakes in and around the wind power station, wind complex Delta do Parnaíba (Figure 1; Table 1). The study area consists of both coastal plains and areas flooded by freshwater, with inclusion of mangroves, lagoons between dunes and "restinga" vegetation, and communities of plants that grow on Quaternary Neosols (Santos-Filho *et al* 2011). This area also suffers anthropic pressure and is already in depleted state due to plant extraction, subsistence agriculture, fishing and livestock.

Data collection

The fish were captured under license #34869-1 from the Ministério do Meio Ambiente (MMA) and the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). The collections were made in and around a wind farm, wind complex Delta do Parnaíba, using standard ichthyological gear, including sieves, seines and throw nets. Its mesh size varied between 3 and 2 cm between the opposing knots. Two floating gillnets were deployed with 10 m long and 1.5 m depth. The mesh size varied between 3 and 16 cm between the opposing knots, with sections mounted in random order. The sampling effort was 60 min at each site, except for the locality at Igaraçu River where two gillnets blocking fish passage were kept open for 12 h. The collected

specimens were cryoanesthetized in an ice box, fixed on-site in 10% formalin solution before being transferred to a 70% ethanol solution. All specimens collected were deposited in a new collection, the Coleção Zoológica do Delta do Parnaíba (CZDP), at the Universidade Federal do Piauí, Reis Veloso Campus, Parnaíba, Piauí. Species identification was based on dichotomic keys, original descriptions, identification manuals and taxonomic reviews (Eigenmann 1915; Géry 1977; Figueiredo and Menezes 1980, 2000; Menezes and Figueiredo 1980; Britski *et al.* 1988; Kullander 1983; Vari 1989, 1991; Ploeg 1991; Ferreira *et al.* 1998; Reis *et al.* 2003; Staeck and Schindler 2006; Buckup *et al.* 2007; Lucena 2007). Species richness and frequencies of the capture of each species were represented by percentages of each species in relation to the total of individuals.

Results

A total of 1,023 individuals, representing 24 species belonging to 13 families and six orders were collected in the lower Parnaíba River (Table 2; Figures 2 and 3). No fishes were captured or observed in four sites (sites 2, 3, 4 and 5). The highest number of species (12) was on site 1. The predominant orders were Characiformes (11 spp.) and Perciformes (8 spp.), representing 45.8% and 33.3%, respectively, of the total fish species captured. The families with higher species richness were Characidae (29.2%), followed by Cichlidae (16.3%), Curimatidae (8.3%), Erythrinidae (8.3%) and Scianidae (8.3%), respectively. The species with the greatest abundance largest number of individuals were *Serrapinnus piaba* (34.8%), *Astyanax aff. bimaculatus* (22.9%), *Serrapinus heterodon* (11,2%) and *Psellogramus kennedyi* (7.8%). The predominance of the Characiformes, mainly Characidae, is consistent with the general pattern found by other authors for the Neotropical region (Lowe-McConnell 1987; Buckup *et al.* 2007; Barros *et al.* 2011).

Discussion

No fish was captured or observed in lakes with abundant vegetation and less than 0.8 m depth and may be related to predatory action and water quality. It has been recorded in northern Piauí State that very deep lakes

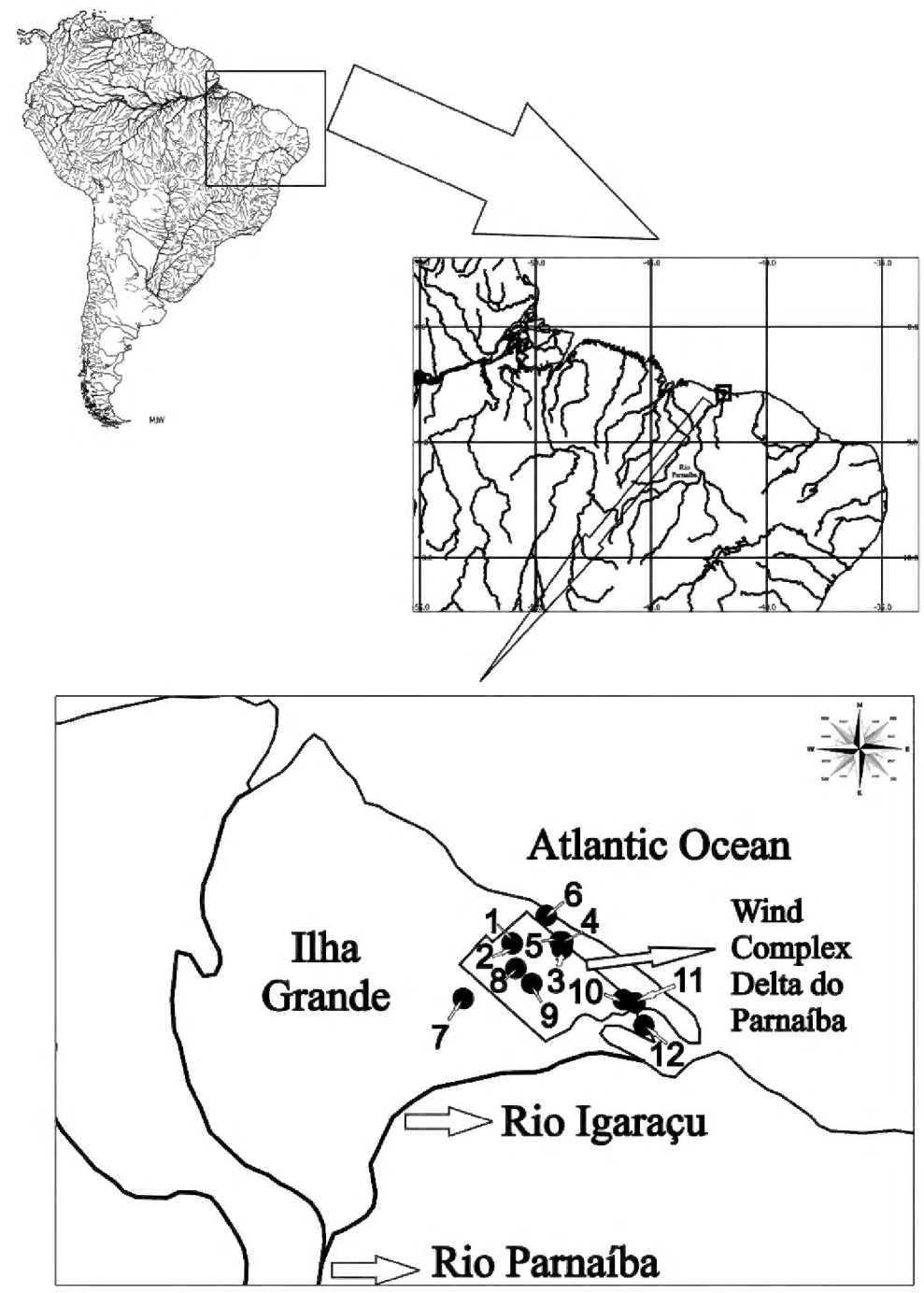

Figure 1. Map of the study area showing the collecting sites in lower Parnaíba River basin, Piauí State Brazil, Ilha Grande.

expose fish to bird predation (Guzzi *et al*. 2012).

The species collected in the present study are equivalent to 17.4% of the species listed by Rosa *et al.* (2003) for the Maranhão-Piauí part of the northeastern ecoregions 323 and 325 of Abell *et al*. (2008) and 11.6% of species recorded in the Parnaíba River basin by Ramos *et al* (2014). Six species, *Cichlasoma orientale, Curimata macrops, Crenicihla menezesi, Geophagus parnaibae, Roeboides sazimai,* are endemic to the Brazilian Caatinga (Rosa *et al.* 2003; Lucena 2007), and *C. macrops* and *G. parnaibae* are restricted to the hydrographic region of

Table1. Geographical coordinates from the collecting sites in the mouth of Parnaíba River basin.

SITE	WATER COURSE	MAXIMUM DEPTH	LATITUDE (S)	LONGITUDE (W)
1	Fresh water lake	1.3 m	2°49′49.62″ S	41°44′5.55″ W
2	Fresh water lake. Body water in good conditions	0.8 m	2°49′50.73″ S	41°44′5.07″ W
3	Small body water with. Beginning of eutrophication process.	0.2 m	2°49′57.67″ S	41°42′53.61″ W
4	Fresh water lake. Presence of vegetation on substrate. Water body in the beginning of eutrophication process	0.3 m	2°49′48.07″ S	41°42′52.75″ W
5	Fresh water body in the beginning of eutrophication process. Lake with footprints of pigs and garbage	0.5 m	2°49′47.74″ S	41°42′56.66″ W
6	Fresh water body. Clear water	1.4 m	2°49′10.57″ S	41°43′16.21″ W
7	Pond with clear water	1 m	2°51′9.19″ S	41°45′15.43″ W
8	Pond with clear water	1 m	2°50′26.20″ S	41°44′0.04″ W
9	Pond with clear water	1.2 m	2°50′47.63″ S	41°43′37.41″ W
10	Pond with clear water	One m	2°51′10.65″ S	41°41′26.26″ W
11	Pond in the beginning of eutrophication process	0.5 m	2°51′15.60″ S	41°41′8.67″O
12	Igaraçu River, with salt water great influence of tides, mangrove area	—	2°51′47.84″ S	41°40′56.41″ W

Maranhão/Parnaíba rivers (Vari 1991; Rosa *et al*. 2003; Staeck and Schindler 2006; Barros *et al*. 2011). One species could only be identified to a species complex (*Astyanax* aff. *bimaculatus*). Such difficulty in identification is common among a group of species characterized by the presence of a horizontal oval black spot in the humeral region, two brown vertical bars in the humeral region, and a black spot in the caudal peduncle extended up to the extremity of the median caudal rays (Garutti and Britski 2000; Garutti and Britski 2000; Buckup 2011; Peres *et al.* 2012). Nine species, *Astyanax aff. bimaculatus*, *Hoplias malabaricus*, *Hoplerythrinus unitaeniatus*, *Pygocentrus nattereri*, *Psellogrammus kennedyi*, *Trachelyopterus galeatus*, *Serrapinnus piaba*, *S. heterodon* and *Psellogrammus kennedyi*, are considered native to the Caatinga but are known to be widespread, occurring in several South American river basins. One species, *Oreochromis niloticus*, an introduced African cichlid, was collected on sites 1, 6 and 11 and probably escaped from fish farms. Non-native species represent a serious threat to aquatic environments and native fish species in South America (Vitule 2009). The introduction of exotic species in aquatic environments can cause irreversible damage to biodiversity, because they can compete for food resources with native wildlife, spread parasites, and develop behaviors that modify the habitat in ways that are harmful to other species (Lima-Junior *et al*. 2012).

Three taxa, *Hyphessobrycon* sp., *Mugil* sp. and *Arius* sp. could not be identified to the species level due to poor taxonomic resolution. The single specimen of *Mugil* sp.

Table 2. List of species collected from down Parnaíba River basin, Piauí State, Brazil.

TAXON	SITE 1	SITE 6	SITE 7	SITE 8	SITE 9	SITE 10	SITE 11	SITE 12	FREQUENCY OF CAPTURE
CLUPEIFORMES									
Engraulidae									
Anchoviela lepidentostole (Fowler, 1911)								5	0.5 %
CHARACIFORMES									
Curimatidae									
Curimata macrops Eigenmann & Eigenmann, 1889			1						0.1%
Steindachnerina nonota (Miranda Ribeiro, 1937)	11								1.1%
Characidae									
Astyanax sp. aff. *bimaculatus*	18		7	54	83	1	1		22.9%
Hyphessobrycon sp.	70								7.2%
Psellogramus kennedyi (Eigenmann & Kennedy, 1903)	23		20		33	1	1		7.8%
Pygocentrus nattereri Kner, 1858			2						0.2%
Roeboides sazimai Lucena, 2007	2								0,2%
Serrapinnus heterodon (Eigenmann, 1915)			54	3	55				11,2%
Serrapinnus piaba (Lütken, 1875)	95		144	31	75	2			34.8%
Erythrinidae									
Hoplias malabaricus (Bloch, 1794)	1				1				0.2%
Hoplerithynus unitaeniatus (Spix & Agassiz, 1829)	9								0.9%
SILURIFORMES									
Auchenipteridae									
Trachelyopterus galeatus (Linnaeus, 1766)	9								0.9%
Ariidae									
Arius sp.								3	0.3
PERCIFORMES									
Cichlidae									
Cichlassoma orientale Kullander, 1983	24		8	30	5	7	1		7.5%
Crenicichla menezesi Ploeg, 1991	9					1			1.0%
Geophagus parnaibae Staeck & Schindler, 2006			5						0.5%
Oreochromis niloticus (Linnaeus, 1785)	6	21					18		4.5%
Centropomidae									
Centropomus unidecimalis (Bloch, 1792)								1	0.1%
Carangidae									
Oligoplites palometa (Cuvier, 1832)								1	0.1%
Gerreidae									
Eucinostomus melanopterus (Bleeker, 1863)								2	0.2%
Scianidae									
Ophioscion punctatissimus Meek & Hildebrand, 1925								1	0.1%
MUGILIFORMES									
Mugilidae									
Mugil sp.								1	0.1%
TETRAODONTIFORMES									
Tetraodontidae									
Sphoeroides testudineus (Linnaeus, 1758)								1	0.1%

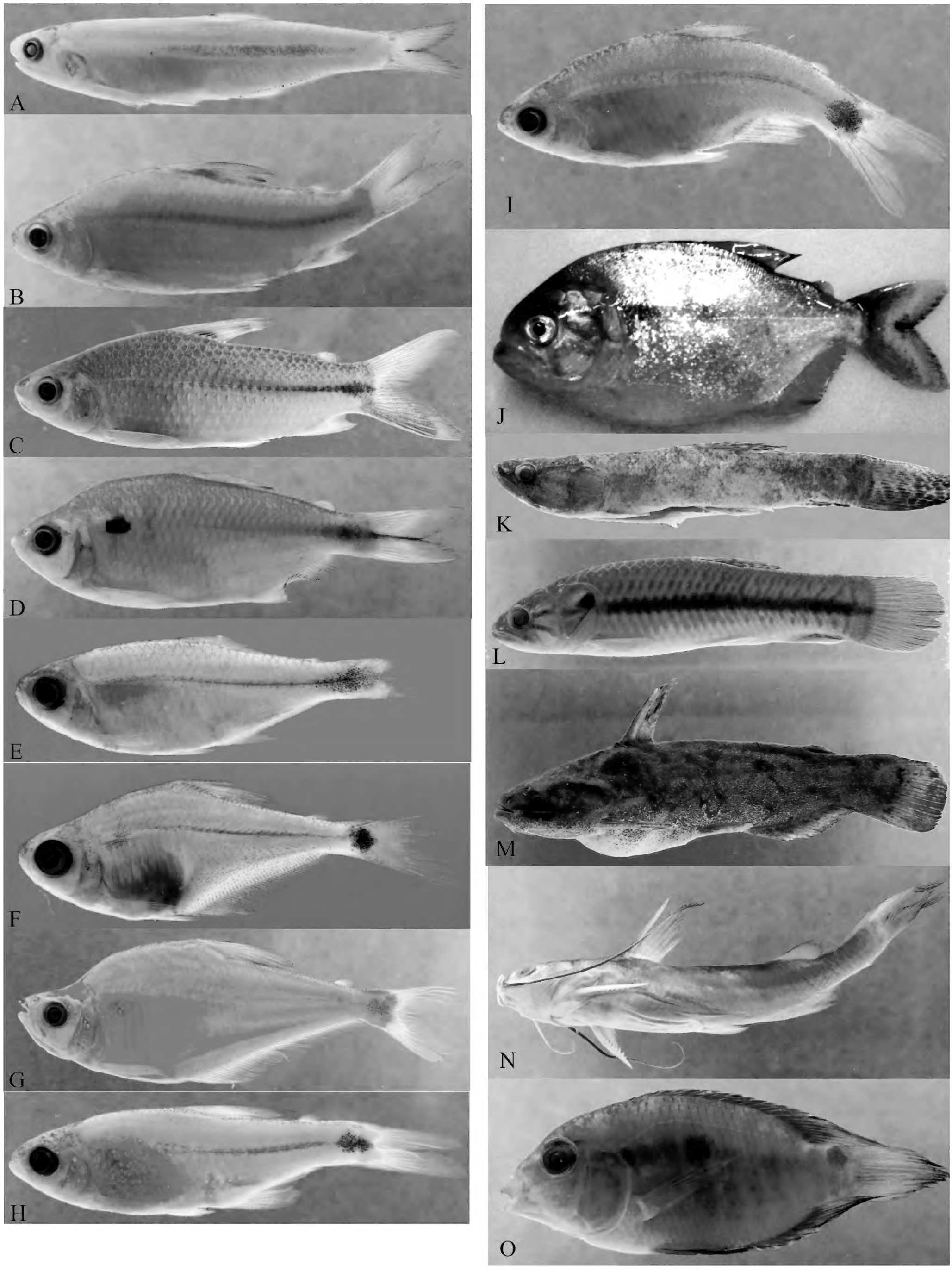

Figure 2. A, *Anchoviella lepidentostole* CZDP 046, 55.7 mm SL; B, *Curimata macrops* CZDP 019, 65.6 mm SL; C, *Steindachnerina notonota* CZDP 03, 68.2 mm SL; D, *Astyanax* sp. Aff. *A. bimaculatus* CZDP 04, 64.2 mm SL; E, *Hyphessobrycon* sp. CZDP 024, 24.4 mm SL; F, *Psellogramus kennedyi* CZDP 07, 29.0 mm SL; G, *Roeboides sazimai* CZDP 08, 71.0 mm SL; H, *Serrapinnus heterodon* CZDP 030, 25.6 mm SL; I, *Serrapinnus piaba* CZDP 023, 28.1 mm SL; J, *Pygocentrus nattereri* CZDP 018, 75.7 mm SL; K, *Hoplias malabaricus* CZDP 026, 113.0 mm SL; L, *Hopleritrhynus unitaeniatus* CZDP 01, 91.0 mm SL; M, *Trachelyopterus galeatus* CZDP 09, 89.1 mm SL; N, *Arius* sp. CZDP 047, 91.0 mm SL; O, *Cichlassoma orientale* CZDP 036, 55.9 mm SL.

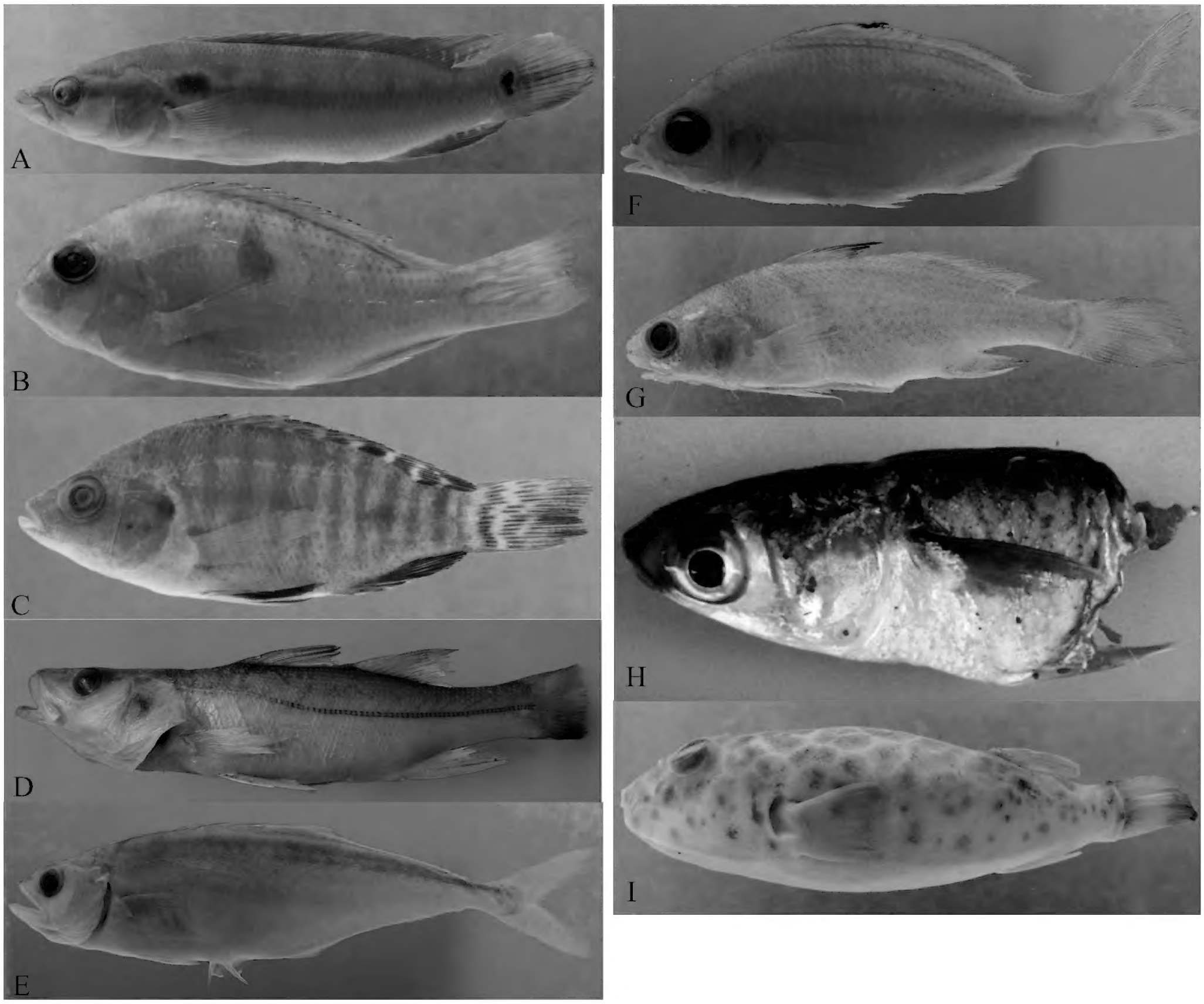

FIGURE 3. A, *Crenicichla menezesi* CZDP 011, 91.9 mm SL; B, *Geophagus parnaibae* CZDP 021, 54.1 mm SL; C, *Oreochromis niloticus* CZDP 012, 34.4 mm SL; D, *Centropomus undecimalis* CZDP 041, 131.5 mm SL; E, *Oligoplites palometa* CZDP 044, 98.4 mm SL; F, *Eucinostomus melanopterus* CZDP 042, 95.3 mm SL; G, *Ophioscion punctatissimus* CZDP 043, 89.9 mm SL; H, *Mugil* sp. CZDP 048, 30.8 mm HL; I, *Sphoeroides testudineus* CZDP 046, 100.6 mm SL.

was found almost destroyed in the gillnet, probably preyed on by another fish.

The most abundant species in terms of total number of individuals was *Serrapinus piaba*, which is also abundant in the rio Ceará Mirim in northeast Brazil (Silvano *et al.* 2003). *Astyanax*, *Serrapinus* and *Psellogramus* showed the greatest distribution. *Serrapinnus heterodon* and *S. piaba* fall within the spatial pattern expected of cheirodontin fish, where they are very abundant inhabitant of lentic and lowland environments (Malabarba, 1998).

Seven species, *Centropomus undecimalis*, *Anchoviella lepidentostole*, *Sphoeroides testudineus*, *Eucinostomus melanopterus, Mugil* sp., *Arius* sp. *and Ophioscion punctatissimus*, were only collected in the lower Parnaíba River, in the mouth of Igaraçu River and are generally captured in shallow waters reefs, islands and especially, bays, canals, estuaries, mangroves, lagoons and coastal rivers (Lessa and Nobrega 2000). These species are also collected in artisanal fish traps, which are set up by fishermen in places with a considerable tidal height variation, off the coast of Piauí State (Mai *et al.* 2012). *Centropomus undecimalis*, *A. lepidentostole*, *E. melanopterus, O. punctatissimus* are commercial fish usually sold in the public markets of northern Piauí (Melo 2012).

Some studies have concerned the effects of wind energy facilities on bat and bird fatalities (Barclay *et al.* 2007). The effects of towers, turbines rotors and electromagnetic field on lakes and its fish fauna inside a wind far are still unknown, so monitoring is necessary to test future hypothesis of environmental impact.

Dichotomous identification key to fishes from small lakes around mouth of the Parnaíba River

1a Skin with spines, teeth modified in hard plates .... *Sphoeroides testudineus* (Figure 3I)
1b Skin without spines, teeth not modified in hard plates 2
2a Fins with spines 3
2b Fins without spines 13
3a Pectoral fin in dorsal position or above middle line of the body .... Mugilidae (1 species), *Mugil* sp. (Figure 3H)
3b Pectoral fin not in dorsal position, or below middle line of the body 4

4a Barbells present 5
4b Barbells absent 6
5a Barbell reaching dorsal fin origin. Forked caudal fin ..... Ariidae (1 species), *Arius* sp. (Figure 2N)
5b Barbell not reaching dorsal fin origin. Not forked caudal fin ..... Auchenipteridae, (1 species), *Trachelyopterus galeatus* (Figure 2M)
6a Lateral line interrupted with dorsal branch and posterior middle caudal peduncle branch ....Cichlidae ... 7
6b Non interrupted lateral line, continuous until caudal fin; ..... Scianidae, Gerreidae, Carangidae, Centropomidae ... 10
7a Superior branch of first branchial arch with a flesh lobule, stripes in longitudinal position along with caudal fin rays .... *Geophagus* (1 species), *G. parnaibae* (Figure 3B
7b First branchial arch without lobule, stripes in transversal position along with caudal fin rays or no stripes 8
8a Parallel stripes in transversal position on caudal fin ..... *Oreochromis niloticus* (Figure 3C)
8b No stripes on caudal fin 9
9a Serrated posterior margin of preopercular bone, dark lateral band along the body .... *Crenicichla* (1 species), *Crenicihla menezesi* (Figure 3A)
9b Non Serrated posterior margin of preopercular bone, stain median dark side..... ..... *Cihlassoma* (1 species), *Cichlassoma orientale* (Figure 20)
10a Serrated posterior margin of preopercular bone .... Centropomidae and Scianidae 11
10b Non Serrated posterior margin of preopercular bone 12
11a Mouth in superior position, prognathous, forked caudal fin .... *Centropomus undecimalis* (Figure 3D)
11b Mouth in inferior position, no prognathous, caudal fin pointed..... *Ophioscion punctatissimus* (Figure 3G)
12a Protractile mouth, spines not prominent on anal fin, nine spines on dorsal fin .... *Eucinostomus melanopterus* (Figure 3F)
12b Non protractile mouth, two prominent spines on the anal fin, five spines on dorsal fin .... *Oligoplites palometa* (Figure 3E)
13a Adipose fin present, no large silvery lateral band, not developed gill rakers ..... Characiformes ... 14
13b Adipose fin absent, large silvery lateral band, developed gill rakers ..... *Achoviella lepidentostole* (Figure 2A)
14a Presence of maxillary teeth ..... 15.
14b Absence of maxillary teeth ..... 23.
15a Keeled abdomen, head and jaws broad and heavy, snout flat, teeth in blade shape .... *Pygocentrus nattereri* (Figure 2J)
15b Abdomen without keel, head and jaws not broad, snout pointed, conical and canine teeth, but never in blade shape 16
16a Conical or canine teeth 17
16b No conical or canine teeth 18
17a Dorsal portion of opercular bone without black spot. Maxillary bone with teeth on proximal portion. Dentary with canine teeth .... *Hoplias malabaricus* (Figure 2K)
17b Dorsal portion of opercular bone with black spot. Maxillary bone and dentary without canine teeth ... . *Hoplerithrynus unitaeniatus* (Figure 2L)
18a Gibbosity in predorsal area. Outer mammaliform teeth in premaxillary bone .... *Roeboides sazimai* (Figure 2G)
18b No gibbosity in predorsal area. No outer teeth in premaxillary bone 19
19a One series of teeth on premaxillary bone, presence of a triangular opening in the musculature covering the anterior part of the swim bladder in both sides of the body, pseudo tympanum, males with procurrent caudal fins developed, caudal peduncle curved .... *Serrapinnus* ... 20
19b Two series of teeth on premaxillary bone, no pseudo tympanum 21
20a Teeth with seven cusps in dentary bone, one large central cusp, remaining others smaller .... *Serrapinnus piaba* (Figure 2I)
20b Dentary teeth with three cusps equally sized .... *Serrapinnus heterodon* (Figure 2H)
21a More than 44 scales on lateral line .... *Psellogrammus kennedyi* (Figure 2F)
21b Less than 41 scales on lateral line 22
22a Completed lateral line, ovate humeral spot, no maxillary teeth ..... *Astyanax* aff. *bimaculatus* (Figure 2D)
22b Not completed lateral line, no humeral spot, maxillary teeth ..... *Hyphessobrycon* sp. (Figure 2E)
23a Three primary mouth folds expanded into large dangling flaps that extend distinctly ventrally from the roof of the oral cavity, no spot in caudal fin rays ..... *Curimata macrops* (Figure 2B)
23b No mouth folds in the roof of the oral cavity, black spot in the middle dorsal fin rays .... *Steindachnerina notonota* (Figure 2C)

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Literature Cited

Abell, R., M.L. Thieme, C. Revenga, M. Bryer, M. Kottelat, N. Bogutskaya, B. Coad, N. Mandrak, S. Contreras Balderas, W. Bussing, M.L.J. Stiassny, P. Skelton, G.R. Allen, P. Unmak, A. Naseka, R. Ng, N. Sindorf, J. Robertson, E. Armijo, J.V. Higgins, T.J. Heibel, E. Wikramanyake, D. Olson, H.L. López, R.E. Reis, J.G. Lundberg, M.H. Sabaj Pérez and P. Petry. 2008. Freshwater ecoregions of the world: A new map of biogeographic units of freshwater biodiversity conservation. *BioScience* 58(5): 403–414 (doi: 10.1641/B580507).

Albert, J.S., P. Petry and R.E. Reis. 2011. Major biogeographic and phylogenetic pattern; pp. 21–57, in: J. Albert and R.E. Reis (eds.). *Historical Biogeography of Neotropical Freshwater Fishes*. Berkeley: University of California Press.

Barclay, R.M., E.F.Baerwald and J.C. Gruver. 2007. Variation in bat and bird fatalities at wind energy facilities: Assessing the effects of rotor size and tower height. *Canadian Journal of Zoology* 85(3): 381–387 (doi: 10.1139/Z07-011).

Barros, M.C., E.C. Fraga and J.L.O. Birindelli, 2011. Fishes from Itapecuru River basin, State of Maranhão, northeast Brazil. *Brazilian Journal of Biology* 71(2): 375–380 (doi: 10.1590/S1519-69842011000300006).

Britski, H.A., Y. Sato and A.B.S. Rosa. 1988. *Manual de Identificação de Peixes da Região de Três Marias (Com Chaves de Identificação Para os Peixes da Bacia do São Francisco*). 3ª edição. Brasília: CODEVASF, Divisão de Piscicultura e Pesca. 115 pp.

Buckup, P.A., N.A. Menezes and M.S. Ghazzi. 2007. *Catálogo das Espécies de Peixes de Água Doce do Brasil*. Rio de Janeiro: Museu Nacional. 195

pp.
Buckup, P.A. 2011. The eastern Brazilian shield; pp. 203–210, in: J.S. Albert and R.E. Reis (eds.). *Historical Biogeography of Neotropical Freshwater Fishes*. Berkeley: University of California Press.
Costa, W.J.E.M., T.P.A. Ramos, L.C. Alexandre and R.T.C. Ramos. 2010. *Cynolebias parnaibensis*, a new seasonal killifish from the Caatinga, Parnaíba River basin, northeastern Brazil, with notes on sound producing courtship behavior (Cyprinodontiformes: Rivulidae) *Neotropical Ichthyology* 8(2): 283–288 (doi: 10.1590/S1679-62252010000200006).
Eigenmann, C.H. 1910. Catalog of the fresh-water fishes of tropical and south temperate America. *Reports of the Princeton University Expeditions to Patagonia 1896–1899*, 3 (Zoology) 375–511 (http://biodiversitylibrary.org/page/23493527).
Eigenmann, C.H. 1915. The Cheirodontinae, a subfamily of minute characid fishes of South America. *Memories of Carnegie Museum* 7(1): 1–99, pls. 1–17.
Ferreira, E.J., J.A.S. Zuanon and G.M. Santos. 1998. *Peixes Comerciais do Médio Amazonas: Região de Santarém, Pará.* Brasília: Edições IBAMA. 211 pp.
Figueiredo, J.L. and N.A. Menezes. 1980. *Manual de Peixes Marinhos do Sudeste do Brasil. III. Teleostei (2)*. São Paulo: Universidade de São Paulo. 90 pp.
Figueiredo, J.L. and N.A. Menezes. 2000. *Manual de Peixes Marinhos do Sudeste do Brasil. VI. Teleostei (5).* São Paulo: Universidade de São Paulo. 116 pp.
Fowler, H.W. 1954. Os peixes de água doce do Brasil. (4a Entrega). *Arquivos de Zoologia do Estado de São Paulo* 9: 1–400.
Garutti, V. and H.A. Britski. 2000. Descrição de uma espécie nova de *Astyanax* (Teleostei, Characidae) da bacia do alto rio Paraná e considerações sobre as demais espécies do gênero na bacia. *Comunicações do Museu de Ciências da PUCRS, Série Zoologia* 13: 65–88.
Géry, J. 1977. *Characoids of the World*. New Jersey: TFH Publications. 772 pp.
Guzzi, A., A.A. Tavares, A.G. S. dos Santos, C.O. Cardoso, D.N. Gomes, J.L.C. Machado, P.C. Silva, R.A.V. Carvalho, S.G.Vilarindo, S.C.A. Batista. 2012. Diversidade de aves do Delta do Parnaíba, litoral piauiense; pp. 290–338, in: A. Guzzi (ed). *Biodiversidade do Delta do Parnaíba — Litoral Piauiense*. Parnaíba: EDUFPI.
Kullander, S.O. 1983. *A Revision of the South American Cichlid Genus* Cichlasoma *(Teleostei: Cichlidae)*. Stockholm: Naturhistoriska Riksmuseet. 296 pp.
Lessa, R and M.F. Nóbrega. 2000. *Guia de Identificação de Peixes Marinhos da Região Nordeste. Programa REVIZEE/SCORE—NE*. Recife: Laboratório de Dinâmica de Populações Marinhas, Departamento de Pesca, UFPE. 128 pp.
Lima, E.F. 2012. Ictiofauna do Delta do rio Parnaíba, Litoral Piauiense; pp. 166–138, in: A. Guzzi (ed.). *Biodiversidade do Delta do Parnaíba—Litoral Piauiense.* Parnaíba: EDUFPI.
Lima-Junior, D.L., F.M. Pelicice, J.R.S. Pelicice and A.A. Agostinho. 2012. Aquicultura, política e meio ambiente no Brasil: Novas propostas e velhos equívocos. *Brazilian Journal of Nature Conservation* 10(1): 88–91 (doi: 10.4322/natcon.2012.015).
Lowe-McConnell, R.H. 1987. *Ecological Studies in Tropical Fish Communities*. Cambridge: Cambridge University. 382 pp.
Lucena, C.A.S. 2007. Revisão taxonômica das espécies do gênero *Roeboides* grupo-*affinis* (Ostariophysi, Characiformes, Characidae). *Iheringia* 97(2): 117–136 (doi: 10.1590/S0073-47212007000200001).
Mai, A.C.G., T.F.A. Silva, and J.F.A. Legat. 2012. Assessment of the fish-weir fishery off the coast of Piauí state, Brazil. *Arquivos de Ciências do Mar* 45(2): 40–48 (http://www.labomar.ufc.br/images/stories/arquivos/ArqCienMar/V45_2_2012/acm_2012_45_2_04.pdf).
Malabarba, L.R. 1998. Monophyly of Cheirodontinae, characters and major clades; pp. 193–233, in: L.R. Malabarba, R.E. Reis, R.P. Vari, Z.M.S. Lucena and C.A.S. Lucena. *Phylogeny and Classification of Neotropical Fishes.* Porto Alegre: EDIPUCRS.
Melo, F.A.G. 2012. Espécies Comerciais de Peixes; pp. 140–207, in: A. Guzzi (ed.). *Biodiversidade do Delta do Parnaíba—Litoral Piauiense*. Parnaíba: EDUFPI.
Menezes, N.A. and J.L. Figueiredo. 1980. *Manual de Peixes Marinhos do Sudeste do Brazil. IV. Teleostei (3)*. São Paulo: Universidade de São Paulo. 96 pp.
Nóbrega, M.F., A.C.G. Mai and D. Loebmann. 2010. Peixes Marinhos Comerciais; pp. 136–181, in: A.C.G. Mai and D. Loebmann (eds.). *Biodiversidade do Litoral do Piauí.* Sorocaba: Paratodos Sorocaba.
Peres, W.A.M., L.A.C. Bertollo, P.A. Buckup, D.R. Blanco, D.L.Z. Kantek, and O. Moreira-Filho. 2012. Invasion, dispersion and hybridization of fish associated to river transposition: Karyotypic evidence in *Astyanax* "*bimaculatus* group" (Characiformes: Characidae). *Review Fish Biology Fisheries* 22: 519–526 (doi: 10.1007/s11160.011-9246-2).
Ploeg, A. 1991. *Revision of the South American Cichlid Genus* Crenicichla *Heckel, 1840, with Description of Fifteen New Species and Consideration on Species Groups, Phylogeny and Biogeography (Pisces, Perciformes, Cichlidae)*. Netherlands: University of Amsterdam. 153 pp.
Ramos, T.P.A., Robson T. da C. Ramos and S.A.Q.A. Ramos. 2014. Ichthyofauna of the Parnaíba River basin, northeastern Brazil. *Biota Neotropica* 14(1): 1–8 (http://www.biotaneotropica.org.br/v14n1/pt/abstract?inventory+bn01014012014).
Reis, R. E., S.O. Kullander and C. Ferraris, Jr. 2003. *Check List of the Freshwater Fishes of South and Central America.* Porto Alegre: Edipucrs. 742 pp.
Rosa, R.S., N.A. Menezes, H.A. Britski, W.J.E. Costa and F. Groth. 2003. Diversidade, padrões de distribuição e conservação dos peixes da caatinga; pp. 135–180, in: I.R. Leal, M. Tabarelli and J.M.C. Da Silva (eds.). *Ecologia e Conservação da Caatinga.* Recife: Editora Universitária da Universidade Federal de Pernambuco.
Santos-Filho, F.S., E.B. de Almeida Jr., L.F. de Melo Bezerra, L.F. Lima and C.S. Zickel. 2011. Magnoliophyta, restinga vegetation, state of Ceará, Brazil. *Check List* 7(4): 478–485 (http://www.checklist.org.br/getpdf?SL001-11).
Staeck, W. and I. Schindler 2006. *Geophagus parnaibae* sp. n.—a new species of cichlid fish (Teleostei: Perciformes: Cichlidae) from the rio Parnaíba basin, Brazil. *Zoologische Abhandlungen Museum für Tierkunde Dresden* 55: 69–75.
Silvano, J., C.L.C. Oliveira, C.B. Fialho and H.C.B. Gurgel. 2003. Reproductive period and fecundity of *Serrapinnus piaba* (Characidae: Cheirodontinae) from the rio Ceará Mirim, Rio Grande do Norte, Brazil. *Neotropical Ichthyology* 1(1): 61–66 9 (http://www.scielo.br/pdf/ni/v1n1/v1n1a07.pdf).
Vari, R.P. 1989. Systematics of the Neotropical characiform genus *Curimata* Bosc (Pisces: Characiformes). *Smithsonian Contributions to Zoology* 474: 1–63 (http://www.sil.si.edu/SmithsonianContributions/Zoology/pdf_hi/SCTZ-0474.pdf).
Vari, R.P. 1991. Systematics of the Neotropical characiform genus *Steindachnerina* Fowler (Pisces: Ostariophysi). *Smithsonian Contributions to Zoology* 507: 1–118 (http://www.sil.si.edu/smithsoniancontributions/Zoology/pdf_hi/SCTZ-0507.pdf).
Virtule, J.R.S. 2009. Introdução de peixes em ecossistemas continentais brasileiros: Revisão, comentários e sugestões de ações contra o inimigo quase invisível. *Neotropical Biology and Conservation* 4(2): 111–122 (doi: 10.4013/nbc.2009.4207).

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Appendix 1. Voucher material
Roeboides sazimai, CZDP 08; *Steindachnerina notonota* CZDP 03; *Hyphessobrycon* sp. CZDP 05; *Astyanax* sp. CZDP 04, CZDP 014, CZDP 022, CZDP 027, CZDP 032, CZDP 037; *Hoplias malabaricus* CZDP 02, CZDP 026 ; *Hoplerithrynus unitaeniatus* CZDP 01; *Psellogrammus kennedyi* CZDP 07, CZDP 015, CZDP 028, CZDP 033,CZDP 038 ; *Cichlassoma orientale* CZDP 010, CZDP 031, CZDP 020, CZDP 025, CZDP 036, CZDP 039; *Crenicichla menezesi* CZDP 011, CZDP 035; *Oreochromis niloticus* CZDP 012, CZDP 013, CZDP 040; *Trachelyopterus galeatus* CZDP 09; *Serrapinnus piaba* CZDP 06, CZDP 017, CZDP 023, CZDP 029, CZDP 034; *Centropomus undecimalis* CZDP 041; *Eucinostomus melanopterus* CZDP 042; *Ophioscion punctatissimus* CZDP 043; *Oligoplites palometa* CZDP 044; *Anchoviela lepidentostole* CZDP 045; *Sphoeroides testudineus* CZDP 046; Ariidae CZDP 047; *Mugil* sp. CZDP 048; *Pygocentrus nattereri* CZDP 018; *Geophagus parnaibae* CZDP 021; *Curimata* sp. CZDP 019; *Serrapinnus heterodon* CZDP 016, CZDP 024, CZDP 030.